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THE SPECTRUM OF R AQUARIi AT MINIMUM BRIGHTNESS

The spectrum of the long-period variable star R *Aquarii* as it appeared in October and November, 1919, shortly before the time of maximum brightness, was described in the December issue of these PUBLICATIONS. In addition to the Md spectrum, which is to be expected in stars showing this type of variability, there appeared at that time several of the lines characteristic of gaseous nebulae. As the star grew brighter the nebular lines grew relatively less intense. Poor observing conditions prevented satisfactory observations at Mount Wilson in the short time that remained after maximum before the object was lost in the western sky. Such plates as were obtained, however, indicated that the nebular lines did not continue to weaken, but either remained of the same intensity or brightened slightly with respect to the Md spectrum.

It therefore appeared possible that the nebular lines might be independent of the variation in light: if this were true they would, of course, be relatively much stronger at the star's minimum brightness. Photographs recently secured show that this is actually the case, tho it is not certain that the nebular lines are wholly invariable in absolute intensities. Since conjunction with the Sun three plates have been secured with the 100-inch telescope and one-prism spectrograph as follows:

Date	Camera	Exposure	Magnitude
June 1, 1920	18-inch	19 min.	9.6 visual
July 6, 1920	18-inch	62 min.	10. visual
July 8, 1920	7-inch	100 min.	

The first plate shows N₁, N₂ and H β , with traces of λ 4363 and H γ . The other two plates show these and additional lines. The following description refers to the plate of July 8th. Bright lines are the only features observable, continuous spectrum being absent or extremely weak.

BRIGHT LINES IN THE SPECTRUM OF R AQUARIi, JULY 8, 1920

Wavelength	Intensity (estimated)	Identification
4102	1	H δ
4340	5	H γ
4363	4	Nebular
4471	$\frac{1}{2}$	Helium
4571	2	Magnesium
4658	trace	Nebular
4861	9	H β
4959	9	Nebular
5007	16	Nebular

The lines $\lambda\lambda$ 4102, 4340, 4363, 4861, 4959, 5007 were reported as present on the plates of October and November, 1919. By comparison of the earlier with the later plates of the autumn series, weak emission lines at $\lambda\lambda$ 4471 and 4658 were noted, which appeared to vary in the same manner as the chief nebular lines. These doubtless correspond to two lines which are included in the above list. On the plate of July 8th λ 4658 is so weak that its reality as judged from this plate alone would be somewhat uncertain, but in view of its presence on the 1919 plates it is believed to represent a real line. Stronger exposures will soon be made which should show this line clearly. It is probably identical with the line given as 4658.2 IA in Wright's list of nebular lines¹.

λ 4571 is almost surely of the same origin as a line which often develops great strength in Md spectra as minimum brightness is approached, becoming in some instances the strongest line in the whole photographic spectrum. It is probably due to magnesium under low temperature conditions.

It is interesting to note that a nebular line near the position of this magnesium line is included in Wright's list. Is it possible that these lines are identical? In any event it might be worth while to examine long exposures on the spectra of certain planetary nebulae to determine whether titanium oxide bands can be detected in the continuous spectrum.

The interpretation of the curious phenomena presented by R *Aquarii* is not yet clear. The fact that the nebular lines are roughly constant in intensity, while the Md spectrum varies thru a large range, suggests that the variable star and the source of the nebular lines are independent objects, yet numerous other observations seem to show rather definitely that they are closely connected. The actual association of the nebular lines with what must be considered as a low temperature spectrum would probably be a cause of surprise to many astrophysicists. It may be of significance in this connection that the high-excitation line λ 4686 has not been observed in R *Aquarii*.

When better understood this anomalous spectrum may prove to be an aid in the physical classification of the nebular lines

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¹Publications of the Lick Observatory, 13, 1918.